The present invention addresses a problem that arises in parallel plate plasma reactors such as that illustrated in Fig. 2 of the present application. There is a need in plasma etching technology for etching with higher aspect ratios and etched profiles that are more vertical, both of which require higher ion energies. In a plasma reactor, such as that shown in Fig. 2, wherein a top electrode is powered by RF in order to dissociate the etchant gas, and the substrate holding electrode is powered by RF in order to accelerate ions toward the substrate, there is a tendency for the ion energy to be low when the plasma density is high.(specification page 6, lines 19-25). Low ion energy gives poor etch quality. The present invention solves this problem by introducing into the plasma reactor chamber a grounded conductive plasma confinement ring. As the application states "By introducing a perforated plasma confinement ring coupled to ground into the plasma processing chamber, electrons from the plasma are substantially removed and the plasma density is reduced, thereby increasing ion energy. The increase in ion energy tends to produce a better etch." (page 6, lines 25-28). The specification further states. The "plasma confinement ring 222 is electrically grounded and formed from a conductor..." (specification page 9, lin16-17). Thus, electrons are removed from the plasma at the grounded conductive confinement ring and the electrons then flow to ground.

Shan et al. addresses a different problem, namely that of excessive ion energy or bias voltage that is damaging to the substrate during the etch process. The plasma reactor in Shan et al. has one RF powered electrode, namely the cathode on which the substrate rests, and one grounded electrode, namely the anode, the anode being spaced apart from the cathode. The bias voltage that develops on the cathode, during plasma etch, is an increasing function of RF power and is also an increasing function of the ratio of effective anode surface area to cathode surface area. (Shan et al. column 4, lines 10-23) The effective anode surface area includes the actual anode area as well as the area of all grounded surfaces that are exposed to the plasma, for example, the grounded chamber wall. (column 4, lines 24-30). Thus, when one attempts to raise the operating RF power, the resulting increase in ion energy or bias voltage damages the substrate being etched. Shan et al. decreases the anode to cathode area ratio by reducing the area of grounded chamber surface that is exposed to the plasma and thus decreases the bias voltage. Shan et al. uses two devices to accomplish this reduction. First, a liner made of dielectric material is located on the inside of the grounded chamber wall. Thus the surface of the liner, a non-grounded surface, is exposed to the plasma rather than the surface of the wall of the chamber which is grounded. Second, Shan et al. uses a "plasma screen 30 that blocks the plasma from forming in part of the etch reactor chamber 10." (Shan et al. column 4, lines 35-36). Thus, the portion of the grounded chamber wall that is located

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below the plasma screen is not exposed to the plasma. Shan et al. states "The presence of the plasma shield reduces the effective surface area of the grounded upper electrode and thereby reduces the dc bias between the lower electrode and the plasma." (column 3, lines 7-11). The reactor disclosed in Hiroto et al. has a dielectric liner and dielectric plasma shield as in Sahn et al. and requires no additional comment.

Thus, there is no teaching or suggestion in Shan et al., or in Hiroto et al.that would lead to the present invention, wherein ion energy is not decreased, as in Shan, but rather increased, and the ion energy increase is not obtained by using an insulating shield to merely confine a plasma but rather by using a grounded conductive shield to confine the plasma and also to conduct electrons from the plasma to ground.

In view of the amendment to claim 1 and in view of the discussion above, it is respectfully requested that the rejection of claims 1, 2, 4, 6 and 9 be reconsidered and withdrawn.

Claims 3, 5, 7-8 and 10-23 stand rejected under 35 U. S. C. 103(a). Applicants respectfully submit that these claims are allowable for at least the reasons stated with regard to claim 1 from which they depend. Applicants respectfully request that the rejection of these claims be reconsidered and withdrawn.

Claims 24 and 26 stand rejected under 35 U. S. C. 103(a) as being unpatentable over Shan et al. and Hiroto et al. The rejection is respectfully traversed.

Shan et al. uses both a chamber liner and a plasma shield to decrease the effective anode area and thereby to decrease the dc bias on the cathode and consequently to decrease the associated the ion energy. In the present invention, a grounded conductive confinement ring is used, not as in Shan et al. to decrease dc bias, but rather to increase ion energy. Therefore, since Shan et al. does not teach ways of increasing energy, but rather the opposite, that which is taught in Shan et al. does not not provide any suggestion that would lead to the present invention.

The statement of rejection notes that in Shan et al. "The plasma shield 35 [30] is composed of an insulating material (abstract) and is connected to the chamber wall which is grounded." Applicants wish to point out that even though the shield 30 may be connected to the grounded chamber wall, the plasma shield 30 is not thereby grounded. The rejected claims require that the perforated plasma confinement ring comprise a conductive ring that is electrically grounded. The required meaning of "grounded" is made clear in the specification, as follows "By introducing a perforated plasma confinement ring coupled to ground into the

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plasma chamber, electrons from the plasma are substantially removed..." (page 6, lines 25-27). Elsewhere in the specification it is stated that "A perforated plasma confinement ring 222 is electrically grounded and formed from a conductor..." (page 9, lines 16-17). In other words, the word grounded as used in the claim, requires that a current of electrons can pass to ground. It is clear therefore that the dielectric insulating plasma shield disclosed in Shan et al. and which is made of dielectric material is not and cannot be grounded in sense required by claim 24.

The statement of rejection further states

> "Shan et al. also teach a chamber liner 44 installed over a portion of the interior wall of the reactor chamber to reduce the effective area of the first (top) electrode and thus reduce the dc bias on the second (bottom) electrode (column 2, lines 55-63). Further control of the dc bias is provided by varying the selection of the materials used for the chamber liner 44. Although preferably of dielectric material, the chamber liner may also be a semiconductor material, or even a conductor such as anodized aluminum. (column 5, lines 32-36)."
>
> Similar to the chamber liner, selection of conductive material rather than a dielectric or insulating material as taught by Shan et al. and Hiroto et al. is considered an obvious modification choice to one of ordinary skill in the art at the time of invention.

When Shan et al. states "Although preferably a dielectric material, the chamber liner may also be a semiconductor material, or even a conductor such as anodized aluminum. The material selection also determines, in part, the effective anode area and, therefore, the dc bias." 9column 5, lines34-38) there is no further discussion on how to arrange the semiconductor material or the anodized aluminum to produce a useful chamber liner. It is clear from an overall reading of Shan et al. that a liner consisting of conductive material in contact with the grounded chamber wall will not work, that is to say will not decrease the effective anode area. In this case the surface of the conductive liner becomes a new grounded surface in place of the chamber wall surface with no reduction in effective anode area.

Therefore, since in Shan et al. the purpose of the invention would be defeated by substituting a grounded conductive liner for the dielectric liner, there is no basis to say that the use of conductive material in a grounded plasma shield is made an obvious modification choice to one of ordinary skill in the art at the time of invention.

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Based on the discussion above and on the amendment to claim 24, it is respectfully requested that the rejection of claims 24 and 26 be reconsidered and withdrawn.

Claims 25 and 27-34 stand rejected under 35 U. S. C. 103(a) as being unpatentable over Shan et al. and Hiroto et al. Since claims 25 and 27-34 depend from claim 24 these claims are allowable for at least the reasons stated with regard to claim 24. Therefore it is respectfully requested that the rejection of claims 25 and 27-34 be reconsidered and withdrawn.

Based on the amendments and the discussion above, Applicants respectfully request a Notice of Allowance for this application, allowing claims 1-34. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at 831-655-2300.

If any fees are due in connection with filing this amendment, the Commissioner is authorized to charge such fees to Deposit Account 50-0388 (Order No. LAM1P098). A duplicate copy of the transmittal is enclosed for fee processing purposes.

Respectfully submitted,

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